2014 Exploration Medical Capability
Standing Review Panel

Status Review for:

The Risk of Unacceptable Health and Mission Outcomes Due to Limitations of In-flight Medical Capabilities

Comments to the Human Research Program, Chief Scientist

2014 Exploration Medical Capability (ExMC) Standing Review Panel (SRP) Status Review WebEx/teleconference Participants:

SRP Members:
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On December 11, 2014, the ExMC SRP, participants from the JSC, HQ, the NSBRI, and NRESS participated in a WebEx/teleconference. The purpose of the call (as stated in the Statement of Task) was to allow the SRP members to:

1. Receive an update by the Human Research Program (HRP) Chief Scientist or Deputy Chief Scientist on the status of NASA's current and future exploration plans and the impact these will have on the HRP.
2. Receive an update on any changes within the HRP since the 2013 SRP meeting.
3. Receive an update by the Element or Project Scientist(s) on progress since the 2013 SRP meeting.
4. Participate in a discussion with the HRP Chief Scientist, Deputy Chief Scientist, and the Element regarding possible topics to be addressed at the next SRP meeting.

Addendum to the Charge:

The ExMC Element is proposing to the Human Research Program a change in the way we quantify the ExMC risk. This assessment will use the Integrated Medical Model (IMM) to take into account the likelihood and consequences of medical conditions in the model with the end goal of using this information to help drive where our gaps and tasks should be focused in order to attain an acceptable risk posture for an exploration mission. The intent is to create a repeatable, evidence-based process for risk reduction that is more quantitative in nature than previous efforts.
Request to the Panel:

Please review the enclosed white paper, and provide comments regarding the strategic approach to managing the ExMC risk.
Based on the presentations and the discussion with the ExMC Element during the WebEx/teleconference, the SRP would like to relay the following information to Dr. Shelhamer, the HRP Chief Scientist.

The proposal to use the IMM was very well received by the SRP participants during the WebEx/teleconference. Current priorities are based on expert opinion and are not quantifiable or subject to reprioritization because they are not based on any data. The IMM will use extensive datasets to calculate the frequencies of various adverse outcomes for at least 100 important medical conditions. The severity of various outcomes will be estimated as quantitatively as possible. The sum of each frequency times the severity for each adverse outcome of a medical condition will represent the cumulative risk of that medical condition.

The IMM will assess the frequency and severity of 100 important medical conditions in terms of the risks of four different adverse outcomes (evacuation, loss of crew life, quality time lost, and resources depleted), taking into account the frequency of each type of adverse outcome for a given medical condition and the frequency of each adverse outcome for a given medical condition. Therefore, for any risky medical condition, the overall risk can be expressed as the sum of the products of the frequency of each condition-associated adverse outcome times the severity of each risk-associated adverse outcome for this risk. This sum is the overall magnitude of risk of any important medical condition.

An extensive database from U.S. astronaut missions will be used to calculate the frequencies of various adverse outcomes. Frequencies of adverse outcomes will be estimated from multiple information sources, including: 1) Lifetime Surveillance of Astronaut data Health data; 2) medical records from Apollo, Skylab, and Mir (US crews only); 3) review of crew medical charts; 4) analog terrestrial data; 5) flight surgeon Delphi Study data; 6) Bayesian analyses; and 7) independent predictive models. The last source, models, will be important in cases where there is sparse data about the frequency or severity of an adverse medical outcome associated with a serious medical condition.

The IMM allows a range of risks to be estimated based on the range of frequencies and the range of severities of each condition-associated adverse outcome. These risks can be divided into risk quartiles based on best case overall risk versus worst case overall risk and then each of these two risk zones can be divided into greater or lesser risk based on whether the condition is treated or untreated. In some cases the estimate of severity has a qualitative aspect, but overall the approach will create a digital portrayal of risk more effectively than previously used methods of risk assessment. One suggestion for NASA would be to organize the 100 important medical conditions not only in alphabetical order, as they are currently listed, but also by organ system so that it will be easier to recognize related diseases on the list. The SRP also strongly recommends that the system of adding diseases anticipate things that have not yet happened on space missions, but could occur with an aging patient population and occupational hazards that have a likelihood to happen.

The IMM has the capacity to identify medical conditions that pose the greatest risk in terms of evacuation, loss of crew life, quality time lost, and resources depleted. Thus NASA can prioritize their focus of research to most effectively mitigate overall risk by using the four basic principles of preventive medicine: 1) safety and prevention; 2) screening; 3) diagnosis; and 4) treatment.

The ExMC SRP members were all very impressed by the novel strategy to manage risk developed by NASA. This IMM method was felt by all to be superior to the prior method, which was based on expert opinion without any element of quantitative frequency or quantitative severity data. The IMM method will be flexible and will easily accommodate newly collected data to remain as a living document with great ongoing value.